

The other numbers correspond exactly with the preceding ; but these suffice to enable us to appreciate what takes place.

It is likewise useless to prolong further the extracts from these works. What we have said is sufficient to show their general character, and the importance of the results already obtained.

We here terminate this rapid and necessarily imperfect revision. But the quantity of materials is considerable, the subjects treated are very varied, and it is very difficult to bring the whole within the limits of a single essay. We hope on another occasion to be able to complete what is deficient here.

## XXV.—On the Development of *Syngamus trachealis*.

By Prof. EHLERS\*.

I AM indebted to the kindness of Baron von Freyburg, of Regensburg, for the opportunity of tracing experimentally the course of development of this worm, which is parasitic in the tracheæ of birds, and, when it occurs in quantity in aviaries, pheasantries, and poultry-yards, produces considerable losses by the destruction especially of young and weakly animals. The parasite was introduced with some exotic birds into the aviary of the Baron von Freyberg during the illness of its owner, and has since occurred there more or less abundantly. The birds attacked by the worm betray this generally at first by a peculiar cough, during which they frequently throw the head to and fro, and not unfrequently at the same time expel small masses, which they generally pick up and swallow immediately. Large birds bear the parasitism of the worm, if it does not occur in too large numbers, for a long time ; small birds, on the contrary, often die suddenly—it would appear, especially by the pair of worms (which, as has long been known, reside in the trachea usually *in copulâ*) placing themselves in such a position that the passage of the air-tubes is stopped, and the birds are suffocated.

In a *Cardinalis virginianus* which M. von Freyberg gave me for examination, and which, according to him, had long been infested by *Syngamus*, I could see the animals in the entrance to the upper larynx, and take them out with a fine forceps. In freshly infected tits, the mucous membrane of the throat was more strongly reddened than usual, and exhibited some very fully charged superficial veins. But the most

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certain character to prove the presence of *Syngamus* in a coughing bird (as the phenomena of coughing may be produced by very different maladies) is the examination of the dung of the bird, because as soon as the disease has continued a little longer, so that the parasites have become sexually mature in the trachea, the ova may be easily found in the dung. I made this observation on the above-mentioned cardinal grosbeak, and found it confirmed when I saw at M. von Freyberg's, in Regensburg, a *Euplectes melanogaster* (Sw.) which coughed a little in the evening and morning, and in whose dung the readily recognizable ova of *Syngamus* immediately occurred.

I made use of the material at my disposal, in the first place, to trace the development and migration of *Syngamus*. *A priori* it was not probable that a bird would acquire the parasite when it ate the ova of a *Syngamus*, since the ova occurred in the dung of birds, and evidently pass through the intestines uninjured when the bird swallows the mucous masses or fragments of the worm containing ova which have been expelled from the trachea. An experiment made in this direction remained so far without result that a canary which I allowed to swallow a female *Syngamus* filled with mature ova did not acquire the parasite.

It seemed more probable that the ova, when expelled from the trachea or evacuated with the fæces, would be developed at first outside the bird. Leuckart's statement\* that the species of the genus *Strongylus* which are parasitic in the lungs have an intermediate form, which lives in an intermediate host, belonging generally to the Insecta, together with the statement of M. von Freyberg, that he had observed the disease among his birds especially after they had been fed with insects, induced me to give cockroaches and mealworms the opportunity of eating the ova of *Syngamus*, and allowing the latter to become developed in them. With insects thus infected I thought to introduce the worm into the birds, but without result. I was, however, soon put upon the track of a simpler mode of development.

The ova of *Syngamus* are developed, with sufficient moisture and warmth, in the open. The mature ovum of *Syngamus* is evacuated by the female in various degrees of segmentation; it occurs under these conditions in the mucus of the air-passages in diseased birds, and somewhat further developed, but always so that the vitellus consists of a number of globules of segmentation, in their fæces. It has a cylindrical or slightly ellipsoidal form, with a length of 0·11 millim. and a breadth

\* Die menschlichen Parasiten, Bd. ii. 1868, p. 402.

of 0·036 millim. A distinctly double-contoured shell forms the external envelope: it exhibits at each pole a circular gap; but even here the entrance to the interior of the ovum is closed by a very fine membrane, which adheres closely to the inner surface of the shell throughout. In the centre of the ovum the dark, segmented vitellus lies in a clear, apparently fluid, substance; in this stage it is 0·084 millim. in length. Such ova I put into earth which was kept moist, or into dung, or into water with or without an intermixture of mucus from the trachea of the birds, or other portions of animal tissue. Here the ova were developed, whether the materials did or did not fall into a state of strong decomposition. The only variation was in the duration of the development, evidently chiefly in dependance on the temperature; for ova which I had set aside for development in an unwarmed room on the 20th September, presented no change for a long time at first, and it was only on the 27th October, when the room was permanently heated, that young worms, rolled into several convolutions, were developed in them. In another case, when the room was kept at a uniform temperature, the ova were developed in the same way in eight days. From a number of ova, although always comparatively few, the young worms escaped at one of the poles of the ovum, where the circular gap existed in the firm egg-shell. The free young worms were filiform, with a blunt head and a pointed tail; the anterior third of the body was translucent; but further on there was a finely granular mass. They were always enveloped by a sheath-like, clear, and extremely fine membrane, which could also be recognized on the young still remaining in the ovum. During this hatching many of the animals died, from not being able completely to quit the egg-shell. Those which acquired their freedom usually moved but sluggishly; and I have been unable as yet to trace their further development. This is evidently only an exceptional case, but still worthy of notice. The majority of the ova remain in a condition in which the young worms developed in them, which now occupy the whole space within the egg-shell, lie quietly or make but few movements. This is not the place to enter upon the details of the development; and it will suffice to state that the development in general takes place as in other parasitic Nematodes.

I made feeding-experiments with ova developed in the above manner. A cole tit (*Parus major*), which I had long observed in a cage in order to convince myself of its good health, received, on the morning of the 3rd November, in a drop of water, a great number of the ova in which the embryos were developed. On the evening of the 20th November

I first heard this tit coughing; but it had struck me a few days previously that the bird was quieter than usual, although in other respects it showed no symptoms to indicate disease. On the next morning I examined the freshly evacuated fæces of the bird, and found in them ova of *Syngamus* in the usual state of development. I killed the tit, and found in its trachea two pairs of *Syngami in copulâ*—a large pair, of which the female was swelled with mature ova, and a smaller pair, the female of which bore only a few mature ova. From the administration of the embryoniferous ova to the time when the disease manifested itself and the *Syngami* were sexually mature, 17 days had elapsed.

A canary to which I had administered embryoniferous ova in the same way, coughed within seven days, and presented remarkable difficulty of breathing; but its fæces contained no developed ova. On the twelfth day after feeding I killed it, and found in the trachea twelve pairs of small *Syngami in copulâ*, but without matured ova. Here the worms produced the diseased phenomena in the trachea of the bird before they had attained full sexual maturity; and this explains the absence of the ova in the fæces.

My investigations are not yet completed. I have still to ascertain the mode of immigration into the trachea, as I am by no means certain whether during the pouring in of the ova they remain adherent at the entrance of the larynx and the whole development takes place in the trachea or the lungs and airsacs, or whether the ova are swallowed (which in my experiments was certainly the case with the majority of them) and the young then quit the egg-shell in the intestine of the bird, bore through the wall of the stomach or intestine, and, entering into the airsacs, thus obtain access to the trachea. From what I have as yet observed in connexion with this, the former would appear to be the way in which the immigration takes place.

Upon this, and upon the structure of the full-grown and of the developing animal, I shall report elsewhere in detail, with reference to the existing literature of the subject. My object in this communication was to state that the ova of *Syngamus* in the open and under various conditions, when deposited in moist localities either with the fæces or the ejections from the trachea of the bird, become so far developed that the parasites escape from them as soon as they are taken up by a bird. By this means a course is to a certain extent indicated in which, by preventive measures, we may protect poultry-yards or aviaries from the immoderate and destructive diffusion of these parasites. Careful observation of coughing birds, in which

the examination of the fæces for ova will give the most certain information as to the presence of these parasites, and measures to make sure that in districts frequently affected by this worm-disease no *Syngami* are introduced at the purchase of new birds, are of the greatest prophylactic value. If the disease make its appearance in great extent, various ways must be adopted, according to the localities, in order to prevent the food-vessels from being contaminated by the fæces or other ejecta, and the soil in damp spots from forming breeding-places from which fresh infections of the birds may continually take place. The custom of many bird-fanciers, of throwing the carcasses of birds among their meal-worms, "in order to make the worms fat," is very well fitted, in the case of the carcasses containing *Syngamus*, to disseminate the ova, which would be readily developed in the moist and warm mass with the meal-worms, and to transfer them, with the latter, into birds.

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#### BIBLIOGRAPHICAL NOTICES.

*Figures of Characteristic British Fossils, with Descriptive Remarks.*

By W. H. BAILY, F.L.S., F.G.S., &c. Part III. Plates 21-30.

*Upper Silurian and Devonian.* Svo. London: Van Voorst, 1871.

THE three parts of this work that have now been published contain 30 lithographic plates, illustrating 504 fossils and their parts, together with explanations and descriptive remarks, which are further illustrated by several woodcuts. With the author's guidance we have learned the meaning of the ancient relics of primæval creatures, which he has arranged for us out of quarry and cabinet, and can value them truly as medals of creation and trustworthy indications of past times and conditions, as the numismatist uses his coins and tokens. Mr. Baily explains the nature of the different types of the great groups of the animal and vegetable kingdoms as they come successively, in relative abundance, in the several formations, and supplies plentiful references to the describers of fossil species, and takes trouble to indicate the distribution of the several typical fossils that his correct judgment leads him to lay before his reader.

We are promised that "Part IV. will complete the Palæozoic division of strata, and conclude vol. i.;" and another such set for "the Secondary" and another for the "Tertiary" strata and fossils will make up the useful and trustworthy work, of which we have had so good a beginning. Though the lithographs are rather woolly, there is no doubt of their accuracy; for the accomplished author cares for them himself. A few *errata* of greater or less importance will have to be noticed:—*Gothlandicus* for *Gotlandicus*, *Calenterata* for *Cœlenterata*, *Cymbæformis* for *Cymbæformis*, *Loxonoma* for *Loxonema*, *Astrea* for *Astræa*; and at p. xlvi, line 23, has for have.